Data-Centric Tutorial, Topics and Demo

Bridging Non Real-Time & Real-Time

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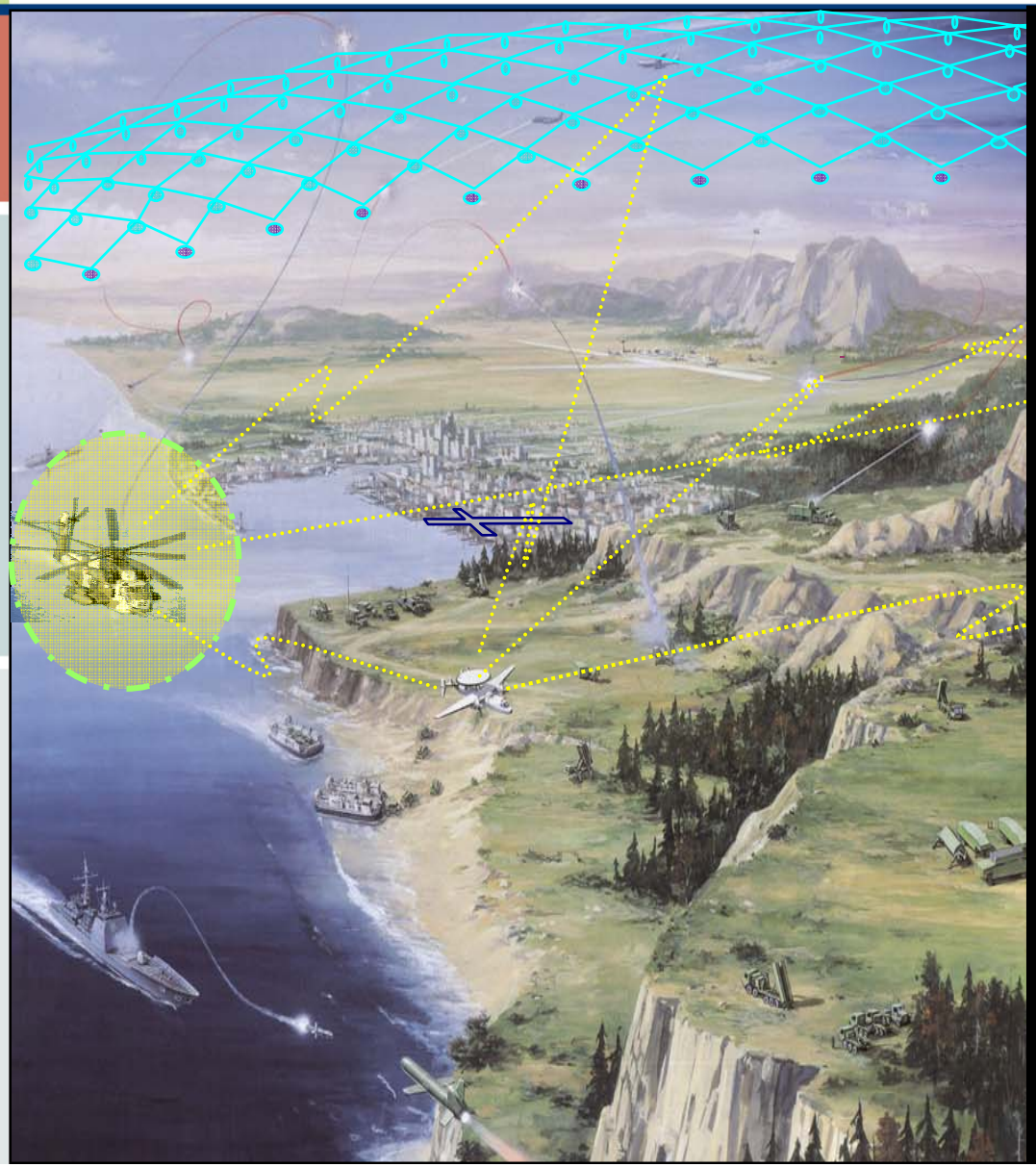
Agenda

- Net-Centricity
  - Challenges and where we are….
- Implementing Net-Centricity
  - Approaches to implementing
- Applicable Standards
  - Data-Distribution Service
  - Data Storage and RDBMS
  - *Service Oriented Architecture*
- Concepts Demo / Q&A

Net-Centric Operations Challenge



More data…
from more sources…
at faster rates…
to more destinations..
via diverse systems...

Increase the
Speed of Command

DoD Net-Centric Tenets

Data

A. DoD Net-Centric Data Strategy
B. Design Tenet: Make data visible
C. Design Tenet: Make data accessible
D. Design Tenet: Make data understandable
E. Design Tenet: Make data trustable
F. Design Tenet: Make data interoperable
G. Design Tenet: Provide Data Management
H. Design Tenet: Be Responsive to User Needs

Services

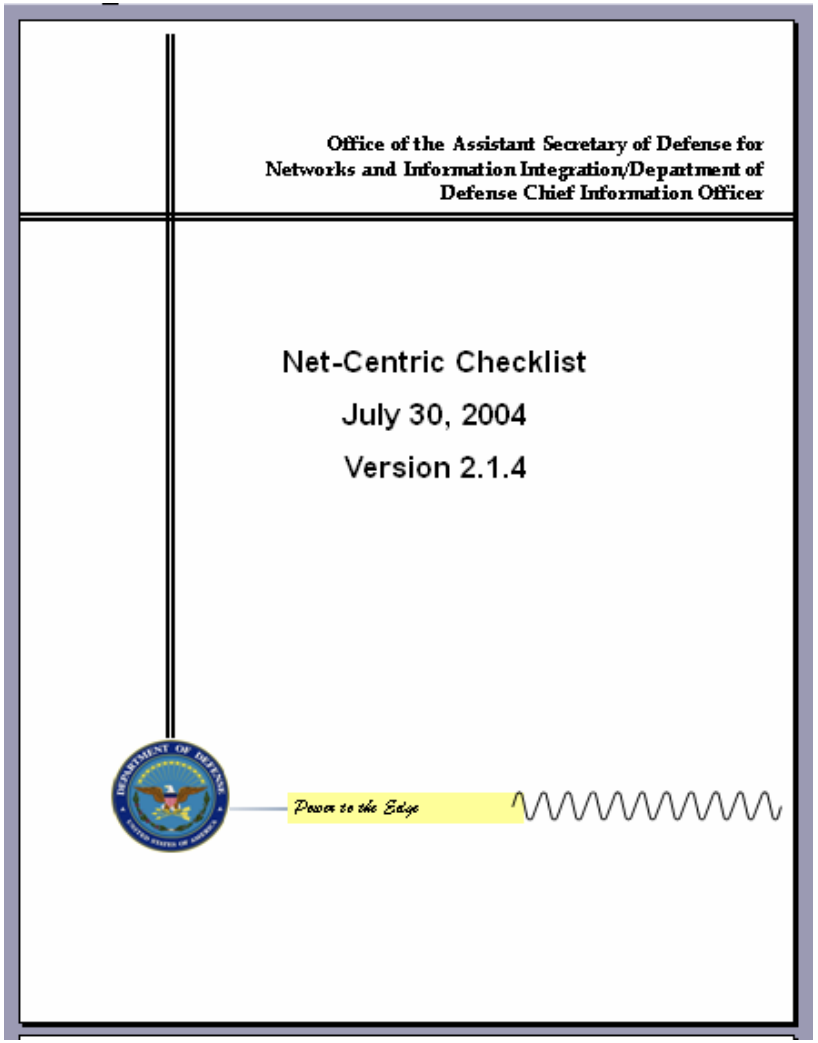
A. Design Tenet: Service-Oriented Architecture
B. Design Tenet: Open Architecture
C. Design Tenet: Scalability
D. Design Tenet: Availability
E. Design Tenet: Accommodate heterogeneity
F. Design Tenet: Decentralized operations and management
G. Design Tenet: Enterprise Service Management

Information Assurance/Security

A DoD Net-Centric IA Strategy
B. Design Tenet: Net Centric IA Posture and Continuity of Operations
C. Design Tenet: Identify Management, Authentication and Privileges
D. Design Tenet: Mediate Security Assertions
E. Design Tenet: Cross Security Domains Exchange
F. Design Tenet: Encryption and HAIPE
G. Design Tenet: Employment of Wireless Technologies
H. Other

Transport

A. Design Tenet: IPv6
B. Design Tenet: Packet Switched Infrastructure
C. Design Tenet: Layering, Modularity
D. Design Tenet: Transport Goal
E. Design Tenet: Network Connectivity
F. Design Tenet: The Concurrent Transport of information Flows
G. Design Tenet: Differentiated Management of Quality-of-Service
H. Design Tenet: Inter-Network Connectivity
I. Design Tenet: Joint Technical Architecture
J. Design Tenet: RF Acquisition
K. Design Tenet: Joint Net-Centric Capabilities
L. Design Tenet: Operations and Management of Transport and Services



DoD Net-Centric Tenets

Data

Data-Centric

G. Design Tenet: Provide Data Management
H. Design Tenet: Be Responsive to User Needs

Service Oriented

D. Design Tenet: Availability
E. Design Tenet: Accommodate heterogeneity

Open Architecture

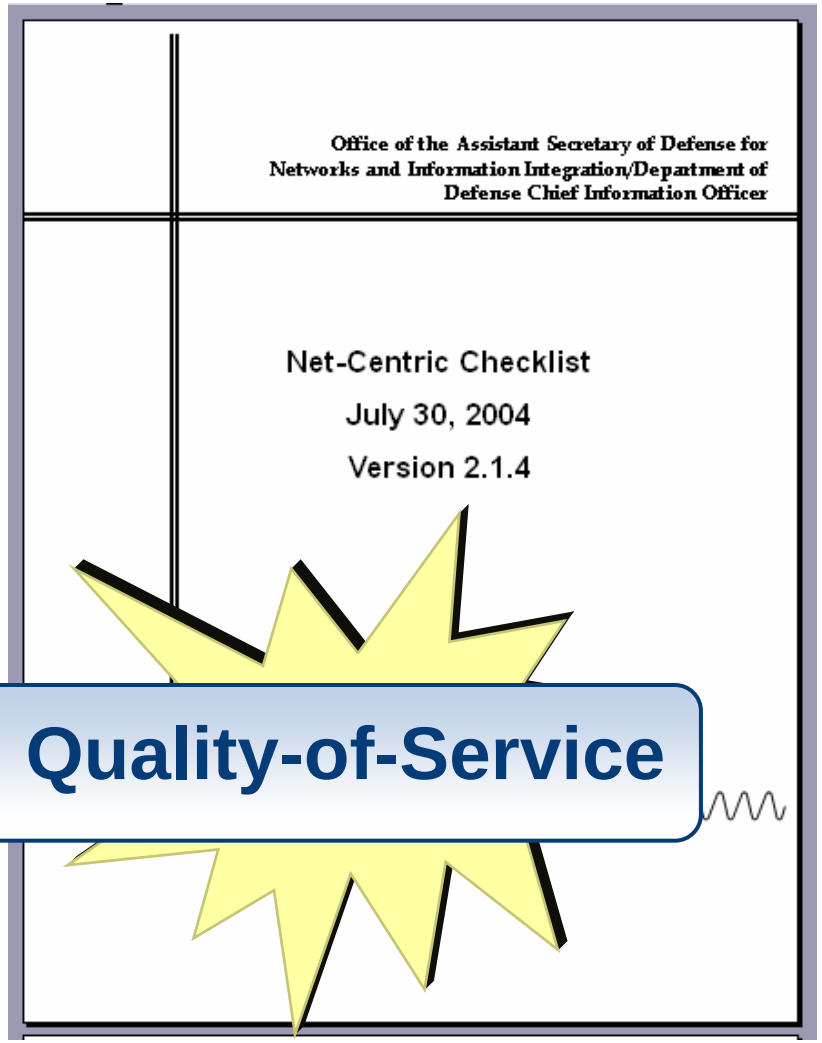
B. Design Tenet: Net Centric IA Posture and Continuity of Operations
C. Design Tenet: Identify Management, Authentication and Privileges
D. Design Tenet: Mediate Security Assertions
E. Design Tenet: Cross Security Domains Exchange

Secured

A. Design Tenet: IPv6
B. Design Tenet: Packet Switched Infrastructure

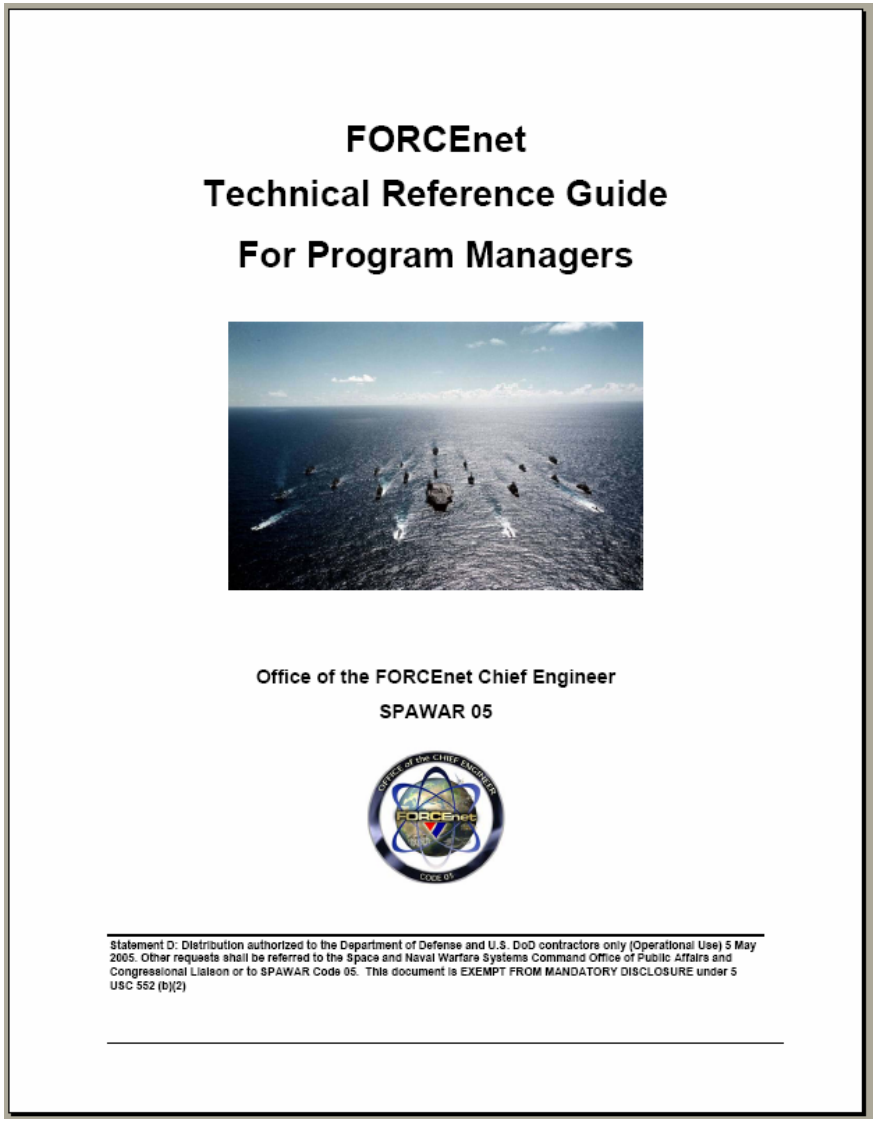
End-to-End

J. Design Tenet: RF Acquisition
K. Design Tenet: Joint Net-Centric Capabilities
L. Design Tenet: Operations and Management of Transport and Services



FORCEnet Technical Reference Guide

- Netcentric Operations/Warfare
- Service Orientated Architecture
  - Reusable services
  - Expose service functionality
  - Abstraction between interfaces and implementations
  - Standard metadata
  - Discovery
  - Standard Protocols
- Composeable platform independent pub/sub
- Distributed web services
- Extensible markup language
- Data-oriented systems
- Real-time systems support
- Human systems integration
- Information Assurance



FORCEnet

Technical Reference Guide

For Program Managers

Office of the FORCEnet Chief Engineer

SPAWAR 05

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FORCEnet Technical Reference Guide

- Netcentric Operations/Warfare
- Distributed web services

Data-Centric

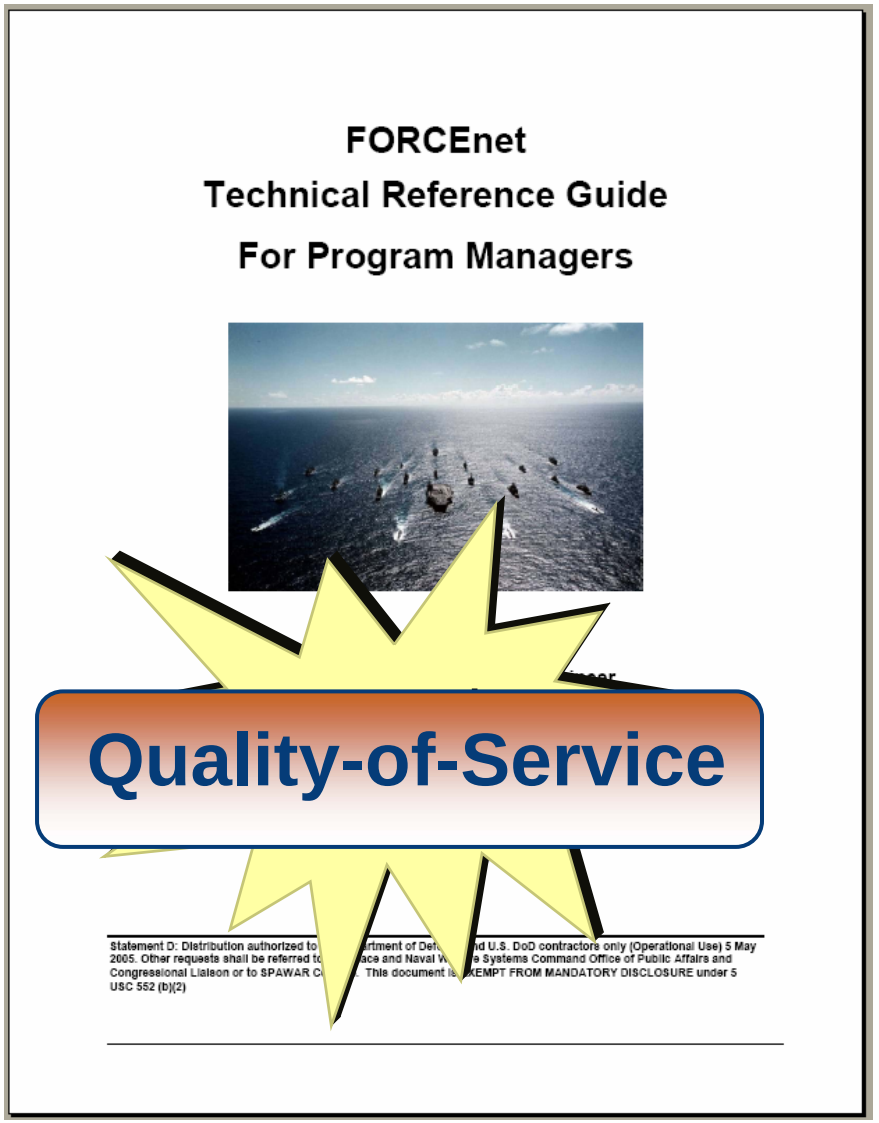
Service Oriented

– Discovery

Open Architecture

Secured

End-to-End



Infantry Communications for the Ground Warrior

First Lieutenant Christopher S. Tsirlis

Communications Officer USMC

TODAY'S GROUND WARRIOR

ASYMMETRIC THREAT

First Lieutenant Christopher S.Tsirlis, Communications Officer USMC

MANY DIFFERENT ASSETS

SINGARS

TA-1042

PSC - 5

PRC-117/150

THURAYA

IRIDIUM

IRAQI CELL

EPLRS

SOME MORE

TDN SERVERS

PRC 119F

BLUE FORCE TRACER
(FBCB2)

PRC-148

ASTRO 5000

LAPTOPS

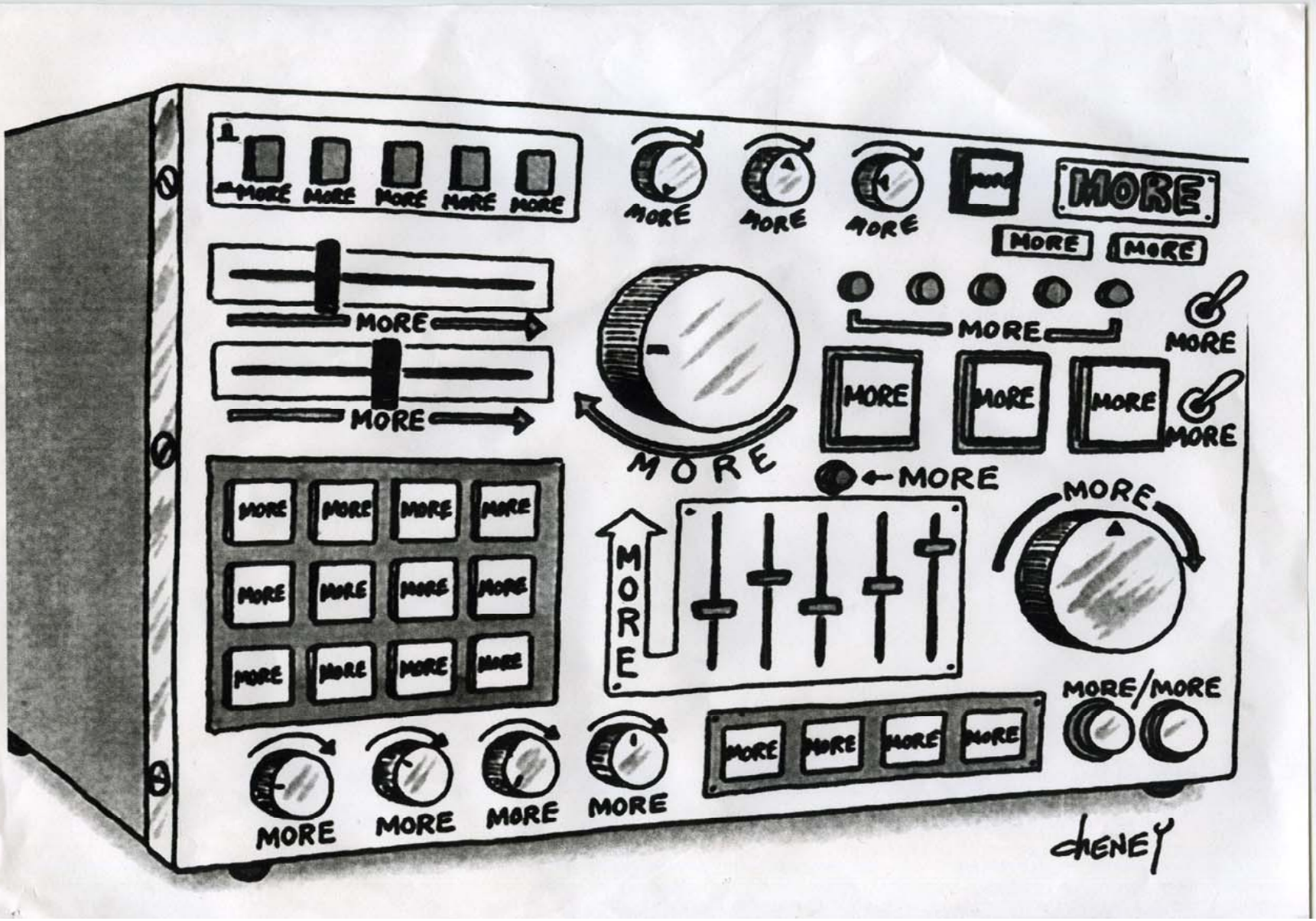
PRR RADIO

TODAYS GROUND WARRIOR

DATA FOR THE INFANTRY

First Lieutenant Christopher S.Tsirlis, Communications Officer USMC

Is it Enough? Where are we Going?



Net-Centricity

How do we get there?

How do we implement it?

Net-Centricity and Programming Paradigms

- Procedural Programming
  - ADA, C, C++, Fortran, …
- Object Orientated Programming
  - Objects, Abstraction, Encapsulation, Polymorphism, Inheritance
- Component Orientated Programming
  - (Dynamic) Semantic Markup, Component Independent Content, Service Interface Encapsulation
- Message Orientated Programming
  - Messages as first class objects
- Data Orientated Programming

Data Orientated Programming

- Tenants of Data Orientated Programming
  - Expose the data
  - Hide the code
  - Separate data and code
    - Data-handling and data-processing
  - Code generated from Interfaces
  - Loosely coupled

Data-Oriented = Data-Centric

Data-Centric = Net-Centric

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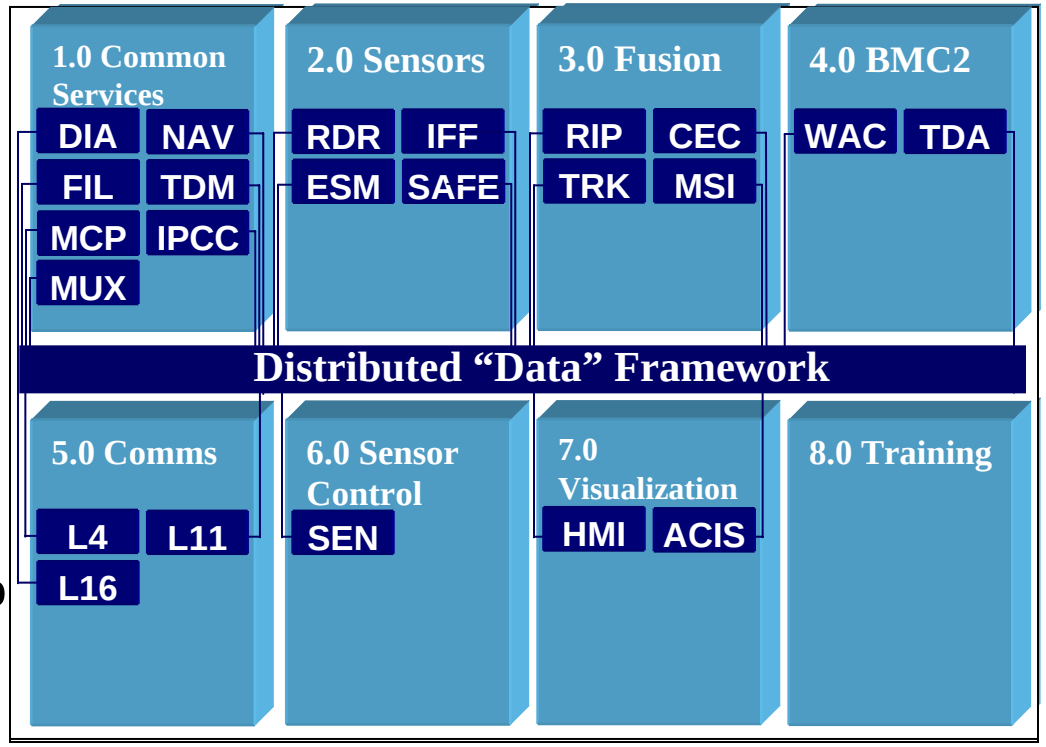
Object-Orientated vs. Data-Orientated

OOP	DOP
Hide the data (encapsulation)	Expose the data (with MR format)
Expose methods – code	Hide the code
Intermix data & code	Separate data & code
Mobile code	Must agree on data mapping, mapping system
API / object model	Messages are primary Data model or schema
Combined processing, no restrictions	Strict separation of parser, validator, transformer, and logic
Changes: Read & change code	Changes: Change declarative data file
Tightly coupled	Loosely Coupled

E-2 Software Component Architecture

- Hawkeye has functionally oriented software modules
- Each module talks to just about every other module
- Adding new functionality drives integration re-work to just about every other module
- Grouping the modules into functional clusters does nothing to change that reality and ease software integration



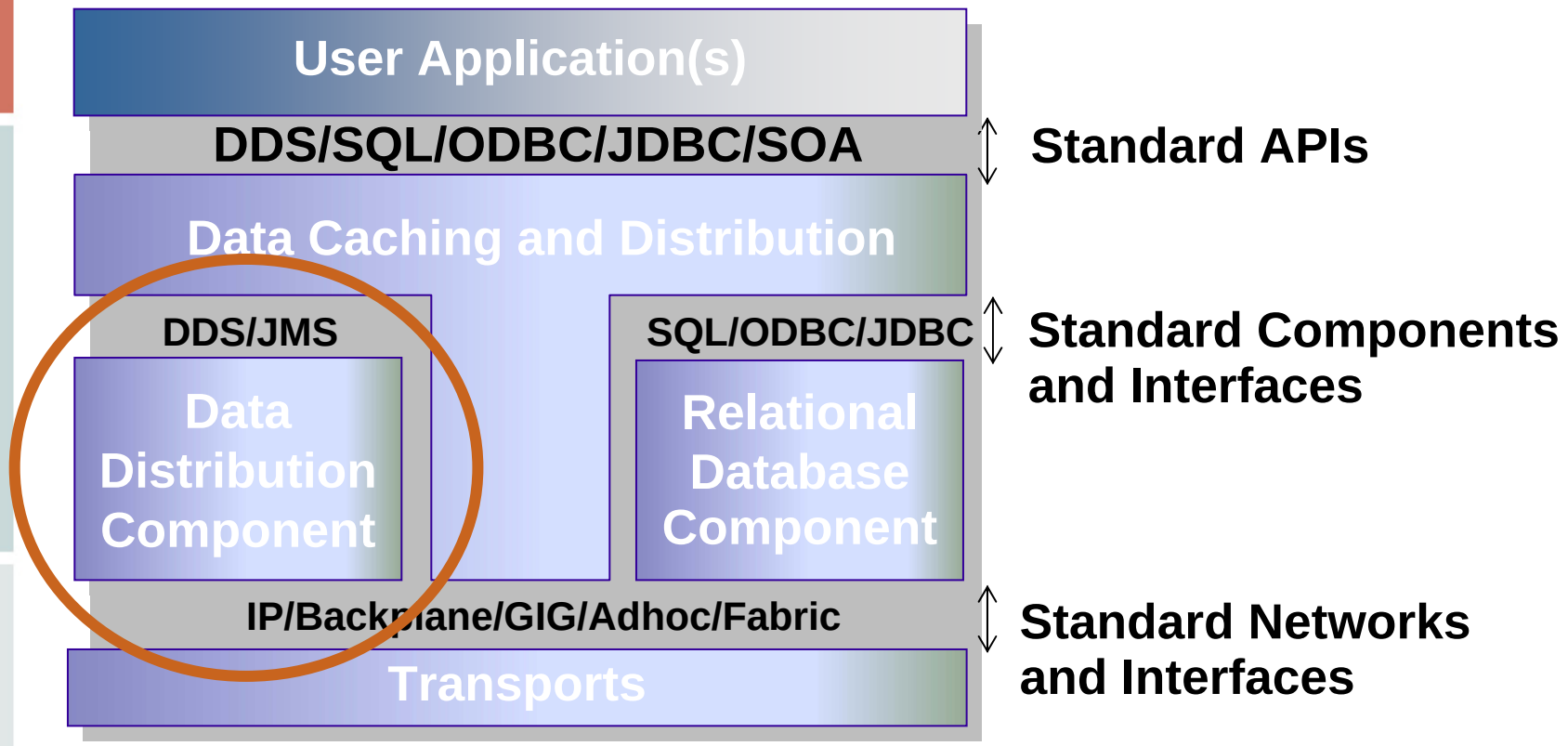
- Changing the communication between the modules can ease integration, when the new 'Publish Subscribe' approach is used – each module publishes its output w/o regard to who is receiving it, in contrast to the point-to-point approach of traditional communication

It's about an architecture that can assimilate evolving functionality, rather than remaining set in time

Standards-Based NetCentricity

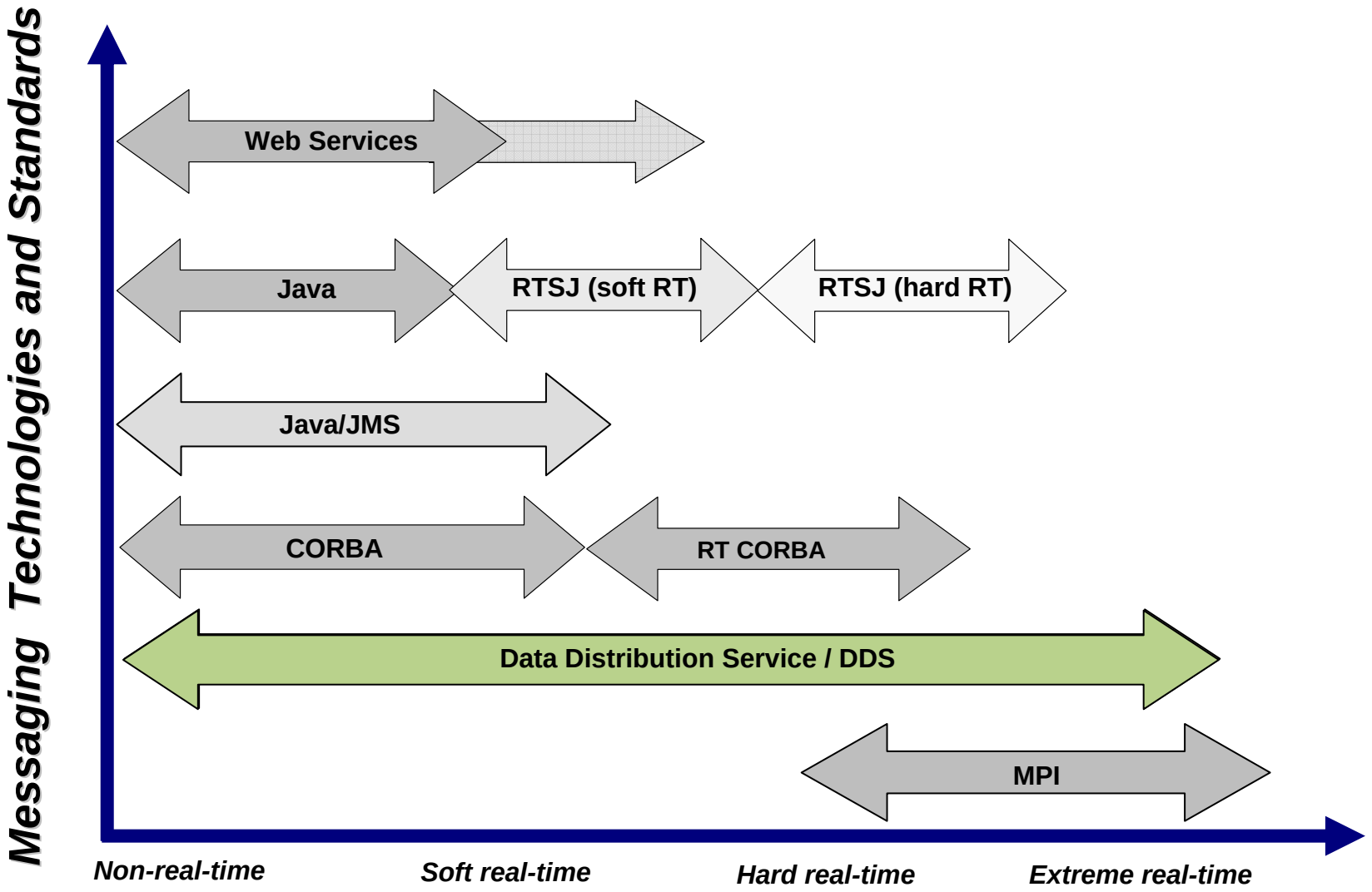
Data Distribution
Data Management
Data Access

Standards-Based Architecture



COTS products implementing a standards-based high-performance distributed data-management solution

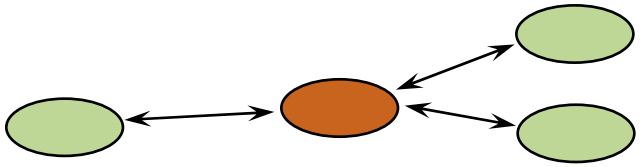
Data-Distribution and Real-Time



Adapted from NSWC-DD OA Documentation

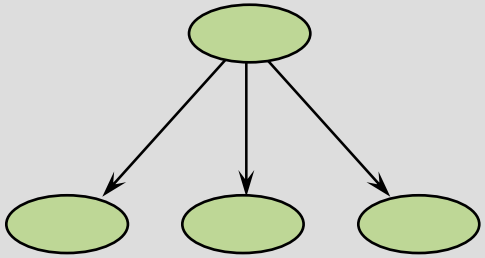
Middleware Information Models

Point-to-Point
Telephone, TCP
Simple, high-bandwidth
Leads to stove-pipe systems

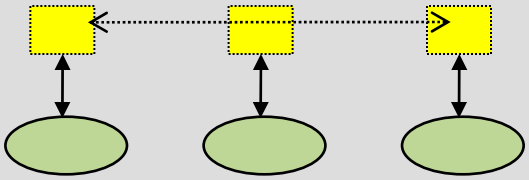


Client-Server
File systems, Database, RPC, CORBA, DCOM
Good if information is naturally centralized
Single point failure, performance bottlenecks

Data Centric Models



Publish/Subscribe Messaging
Magazines, Newspaper, TV
Excels at *many-to-many communication*
Excels at distributing *time-critical information*



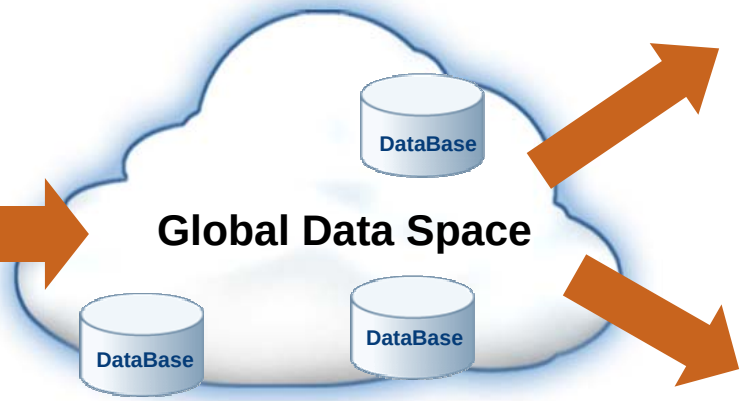
Replicated Data
Libraries, Distributed databases
Excels at data-mining and analysis

Publish-Subscribe Model

- ***Efficient mechanism for data communications***

Publisher does not need to know who the subscribers are.

Subscribers do not need to know where the data "lives" or continually ask for it.



Producer(s)

Middleware

Consumers

Data Distribution Service (DDS) Standard

- Data Distribution Service for Real-Time Systems
  - Adopted in June 2003
  - Revised in April 2005
  - API specification for Data-Centric Publish-Subscribe communication for distributed real-time systems.
  - http://www.omg.org/docs/ptc/05-03-09.pdf

- RTI's role
  - Member of OMG since 2000
  - Co-authors of the original DDS RFP
  - Co-authors of the DDS specification adopted in June 2003
  - Chair of the DDS Finalization and Revision Task Forces
  - Providers of a COTS implementation of the specification

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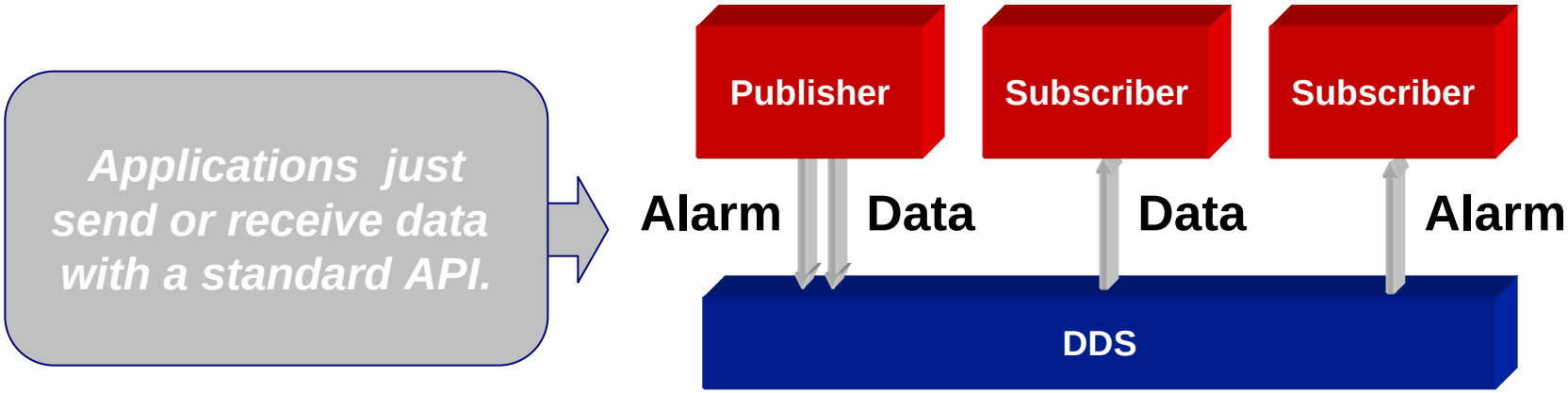
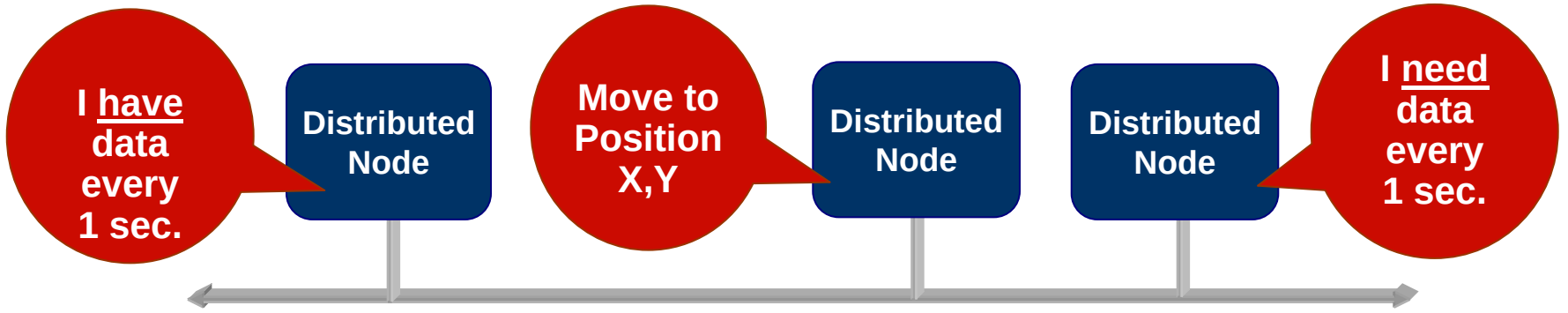
DDS – Loosely Coupled Architecture

- Data-centric communications
  - Just declare your intent to publish or receive data.
  - No need to make a special request for every piece of data.



DDS – Quality of Service

- Data distribution with minimal overhead
  - No reply confirmation needed
  - Very flexible QoS on a per-data-stream basis
    - Determinism vs. reliability
    - Cyclic ←→ acyclic messages
    - Bandwidth control
  - Fault tolerance (esp. over unreliable media)



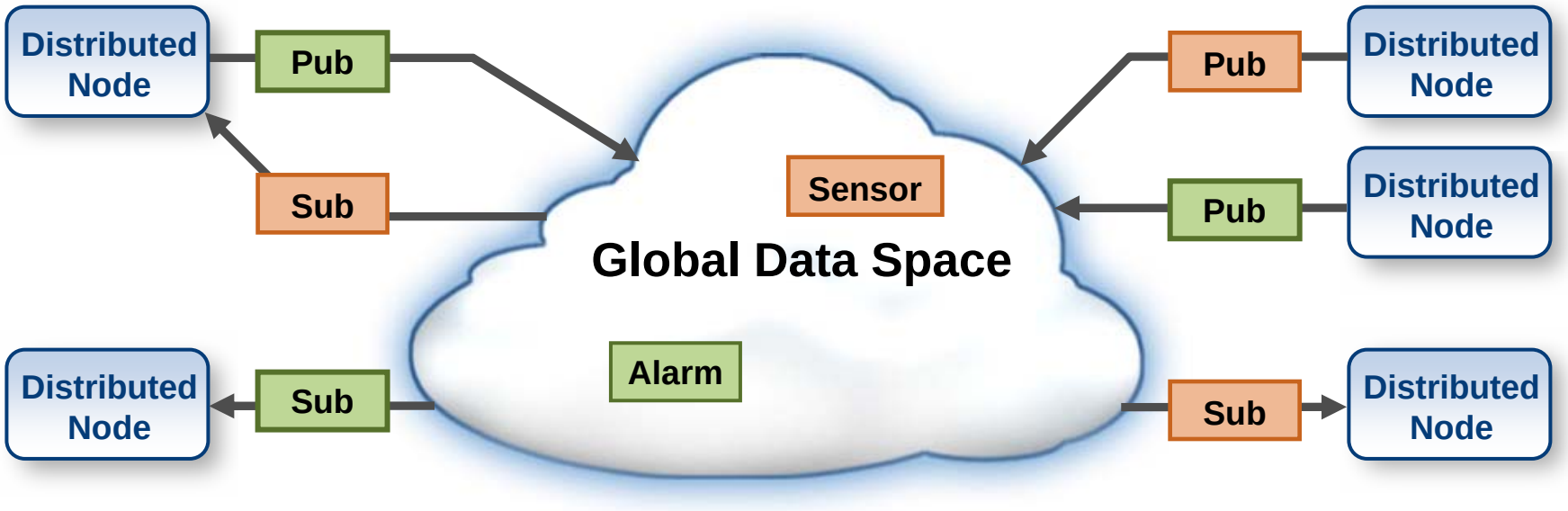
DDS – Advantages

Decoupling

- Location: reduce dependencies
- Redundancy: multiple readers & writers
- Time: data when you want it
- Platform: connect any set of systems

Benefits

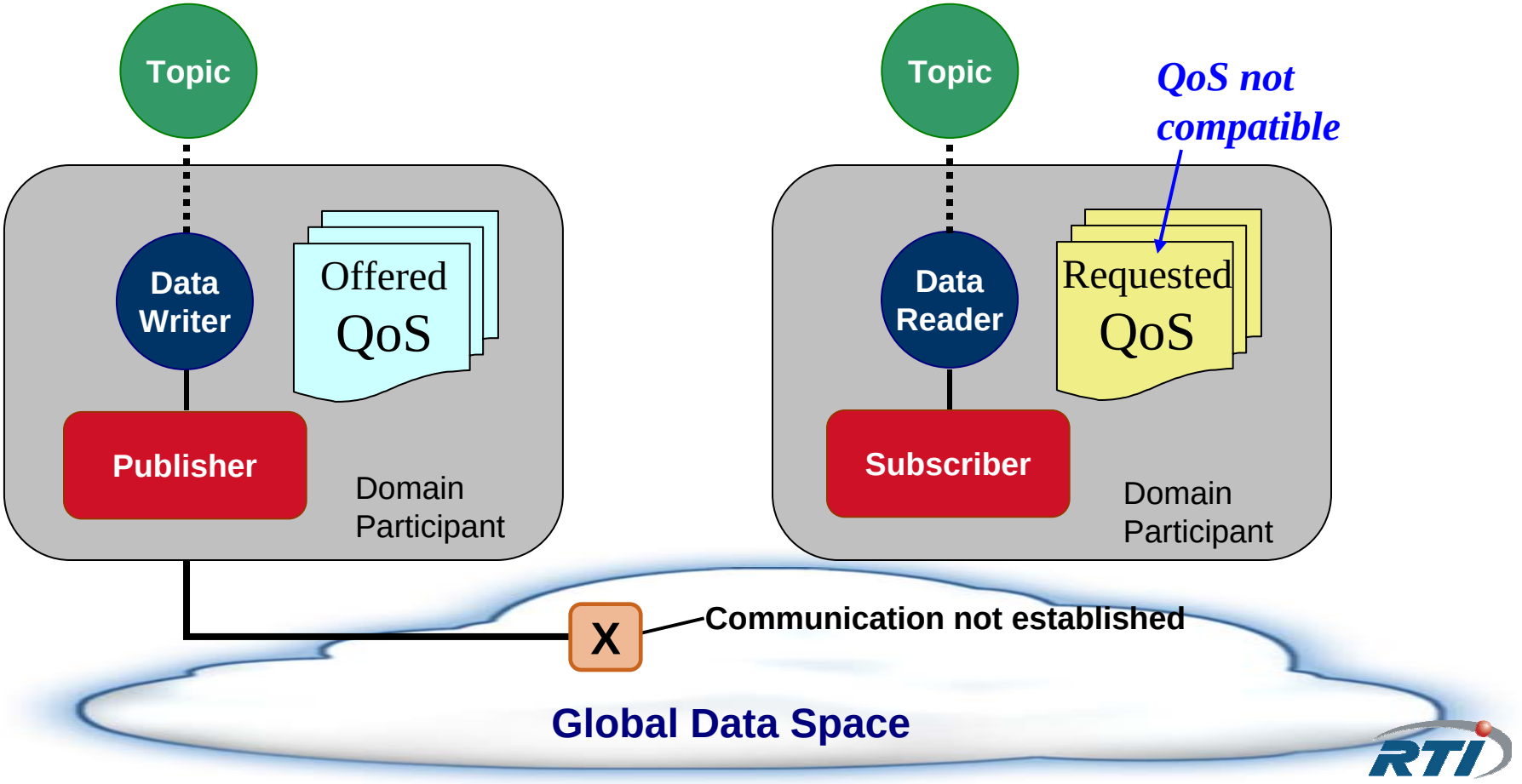
- Modular structure
- Flexibility
- Power



QoS Contract "Request / Offered"

QoS:Latency_Budget
QoS:Ownership
QoS:Liveliness
QoS:Reliability
QoS:Durability
QoS:Presentation
QoS:Deadline
…

Ensure that the compatible QoS parameters are set.



QoS: Quality of Service

QoS Policy	QoS Policy
DURABILITY	USER DATA
HISTORY	TOPIC DATA
READER DATA LIFECYCLE	GROUP DATA
WRITER DATA LIFECYCLE	PARTITION
LIFESPAN	PRESENTATION
ENTITY FACTORY	DESTINATION ORDER
RESOURCE LIMITS	OWNERSHIP
RELIABILITY	OWNERSHIP STRENGTH
TIME BASED FILTER	LIVELINESS
DEADLINE	LATENCY BUDGET
CONTENT FILTERS	TRANSPORT PRIORITY

Volatility

Infrastructure

Delivery

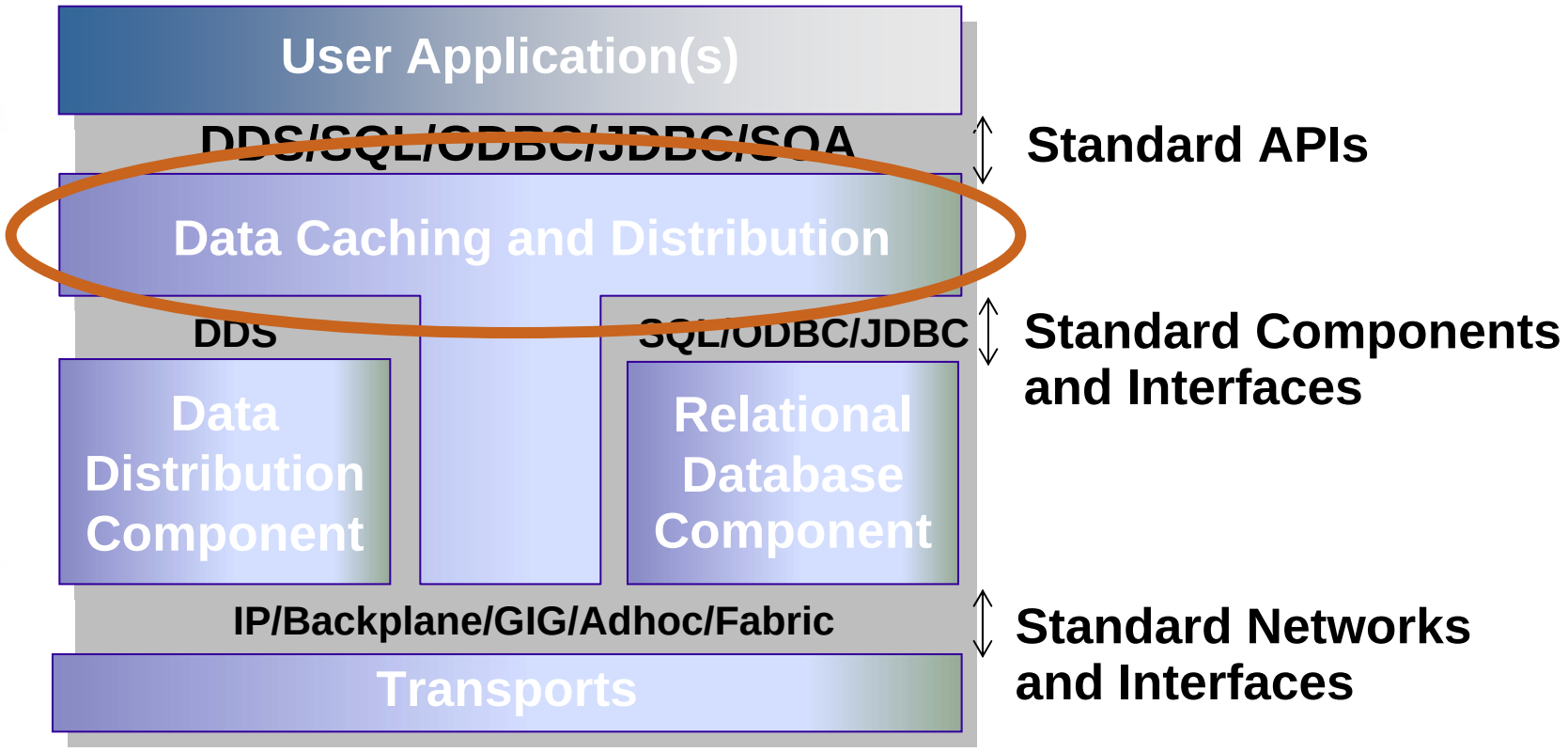
User QoS

Presentation

Redundancy

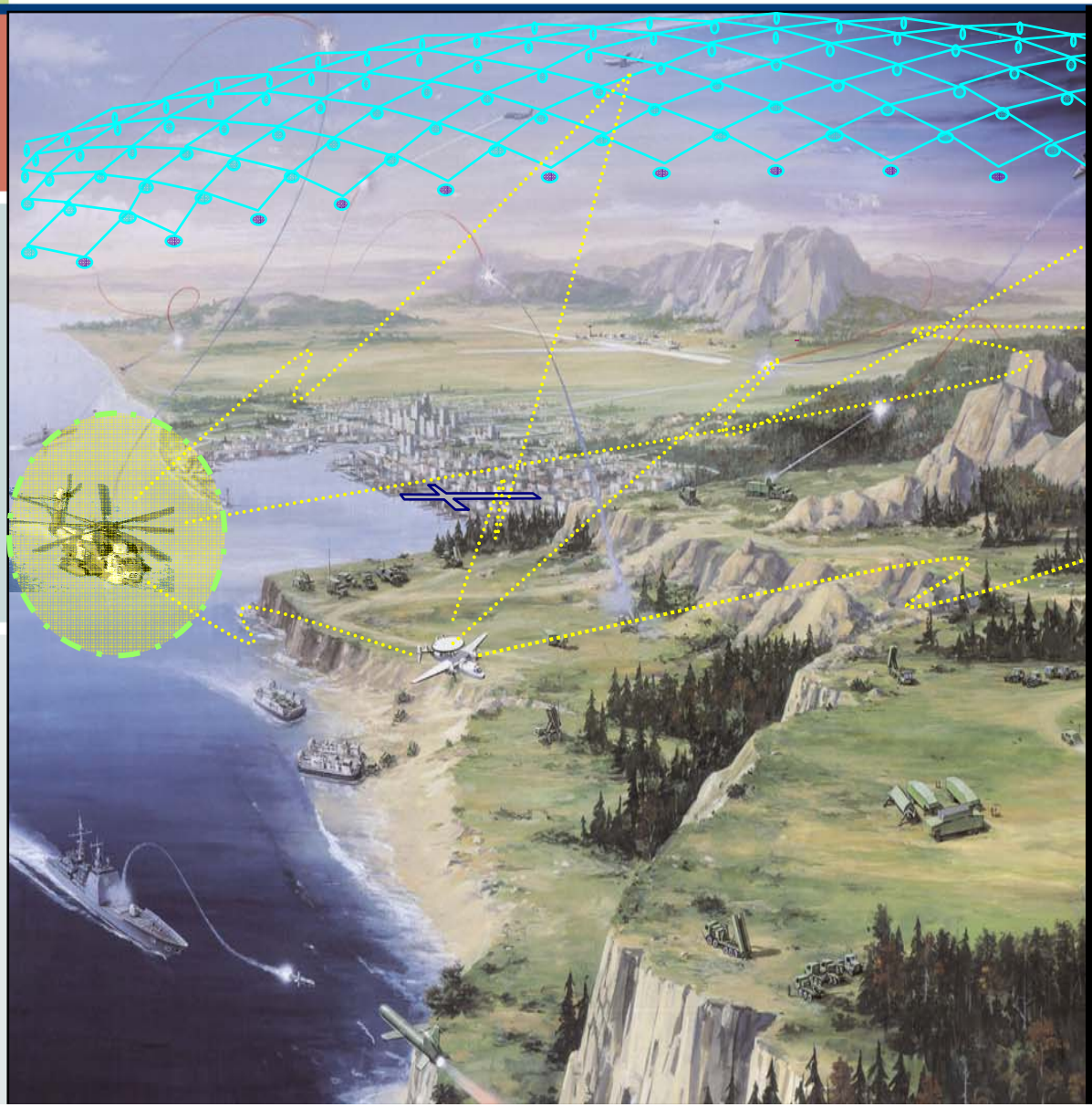
Transport

Standards-Based Architecture



COTS products implementing a standards-based high-performance distributed data-management solution

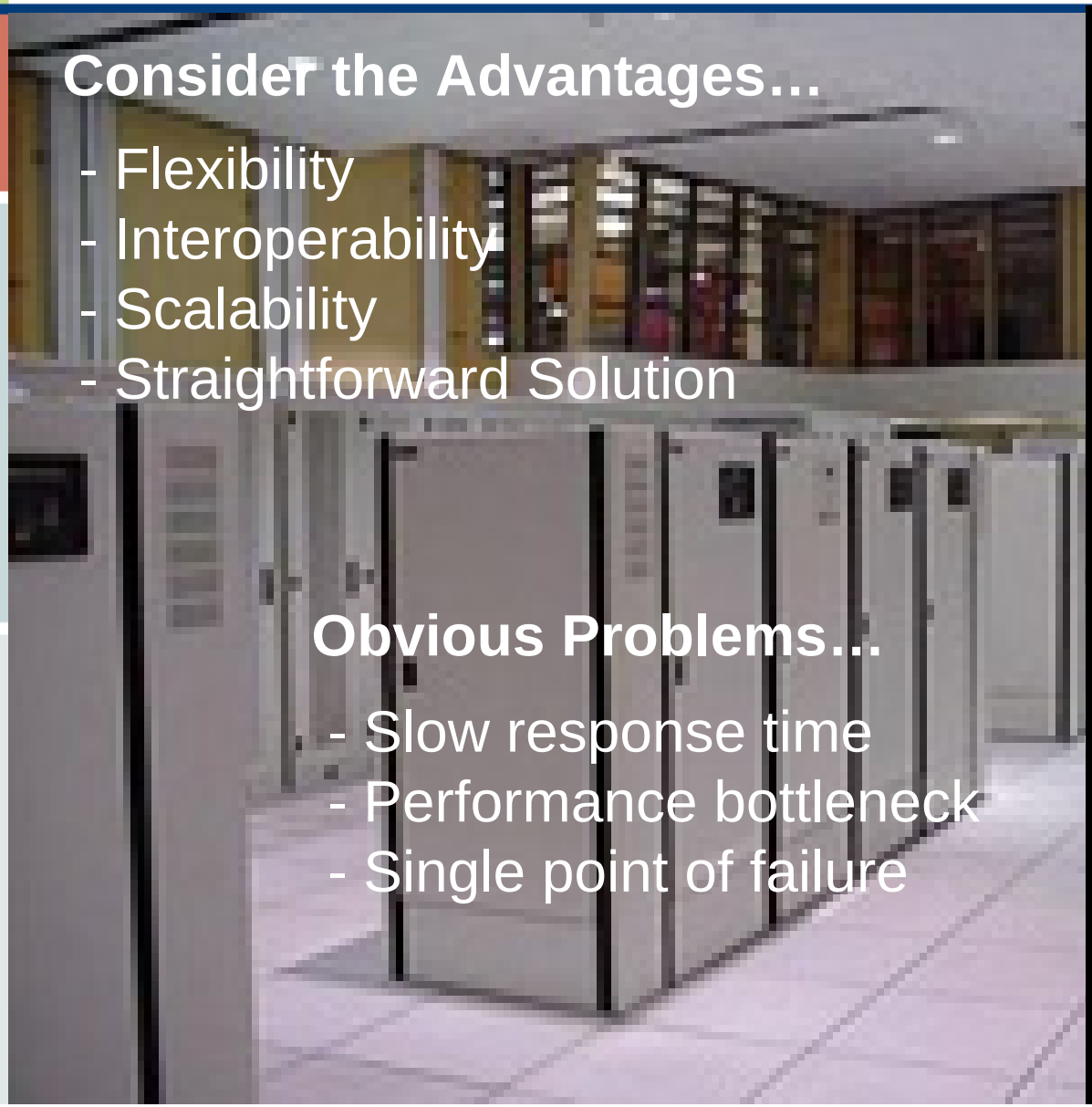
Data Monitoring in an Ever-Changing Environment



How can we manage the rapidly increasing amount of real-time information in net-centric systems?

How do we make information available where and when it is needed?

Centralized Database



Consider the Advantages…

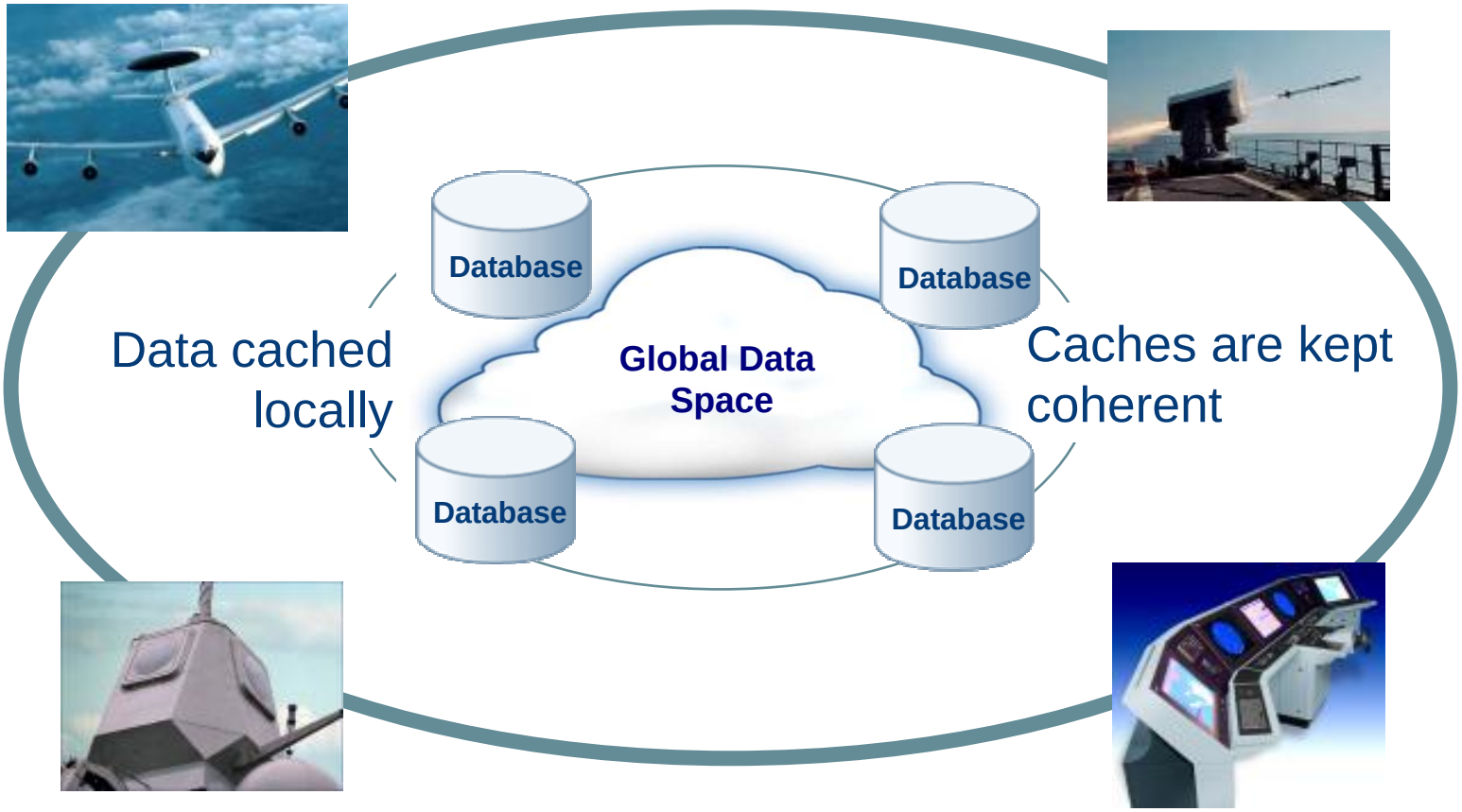
- Flexibility
- Interoperability
- Scalability
- Straightforward Solution

Obvious Problems…

- Slow response time
- Performance bottleneck
- Single point of failure

Ever thought of maintaining critical real-time data in a centralized database?

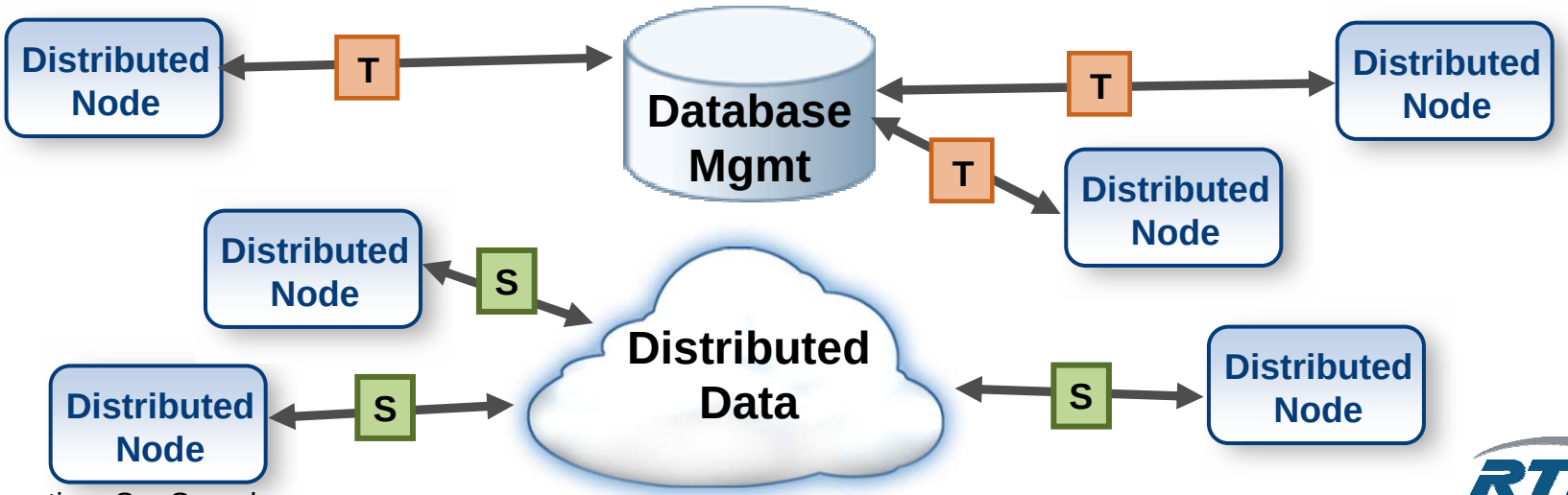
The Network is the Database



Applications view distributed data as if it resides in a centralized database

Today: Different Data Solutions

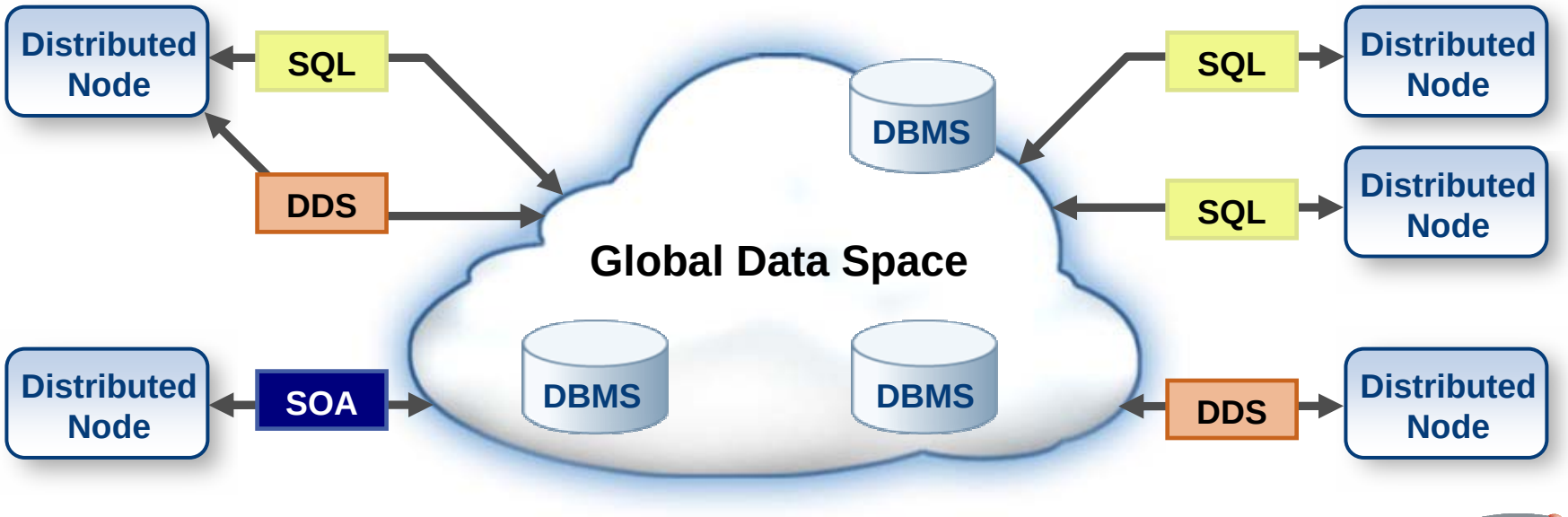
- Database Management Systems
  - Non-RT performance, non-distributed
  - Complex queries, dynamic sorting, standard SQL I/F, enterprise solution
- Data Distribution Services
  - High performance, dynamic architectures, real-time solution
  - What do you do with the data once you get it there?



T= transaction, S = Sample

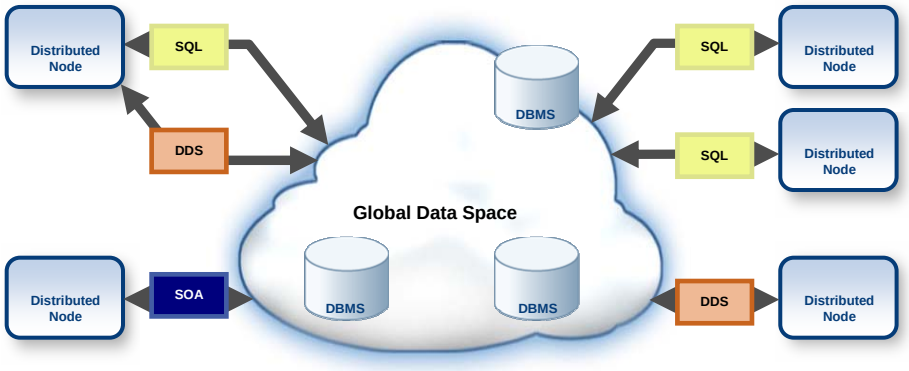
A Standards Based Global Data Space

- Data accessible to all interested applications:
  - Data distribution (publishers and subscribers): **DDS**
  - Data management (storage, retrieval, queries): **SQL**
  - Rich QoS, automatic discovery and configuration
  - Real-time and/or high-performance access to data



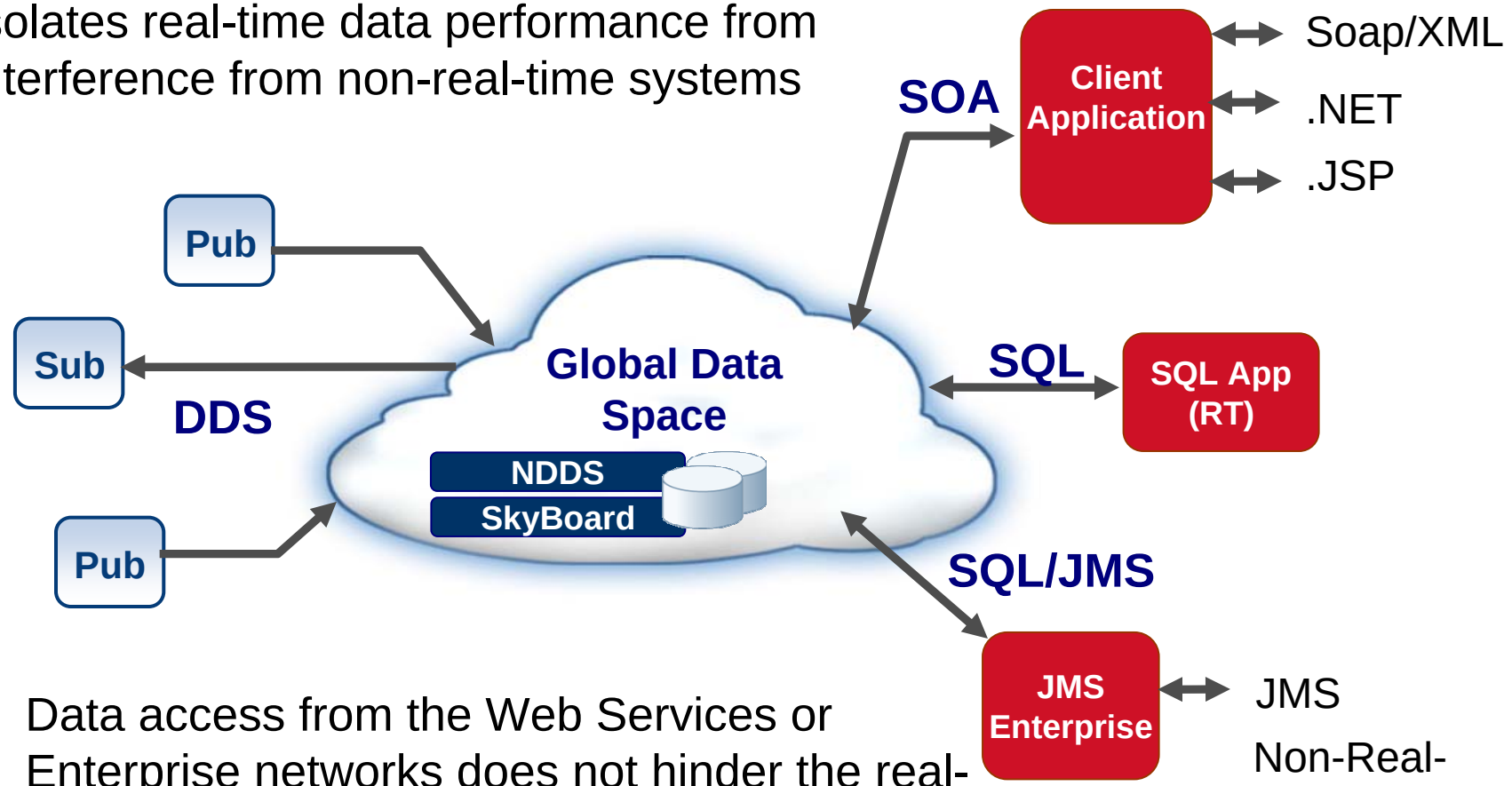
Distributed Data Management

- Embedded-to-Enterprise Connectivity
  - From tiny micro-devices…
  - To enterprise databases
- Flexible DDS networking
  - Automatic peer discovery
  - Full QoS control
  - Fault tolerant
- Distributed database caching
  - Automatic process-data collocation
  - 10 usec data access
  - High-availability of multiple copies
- Standards-based COTS



End-to-End Integration

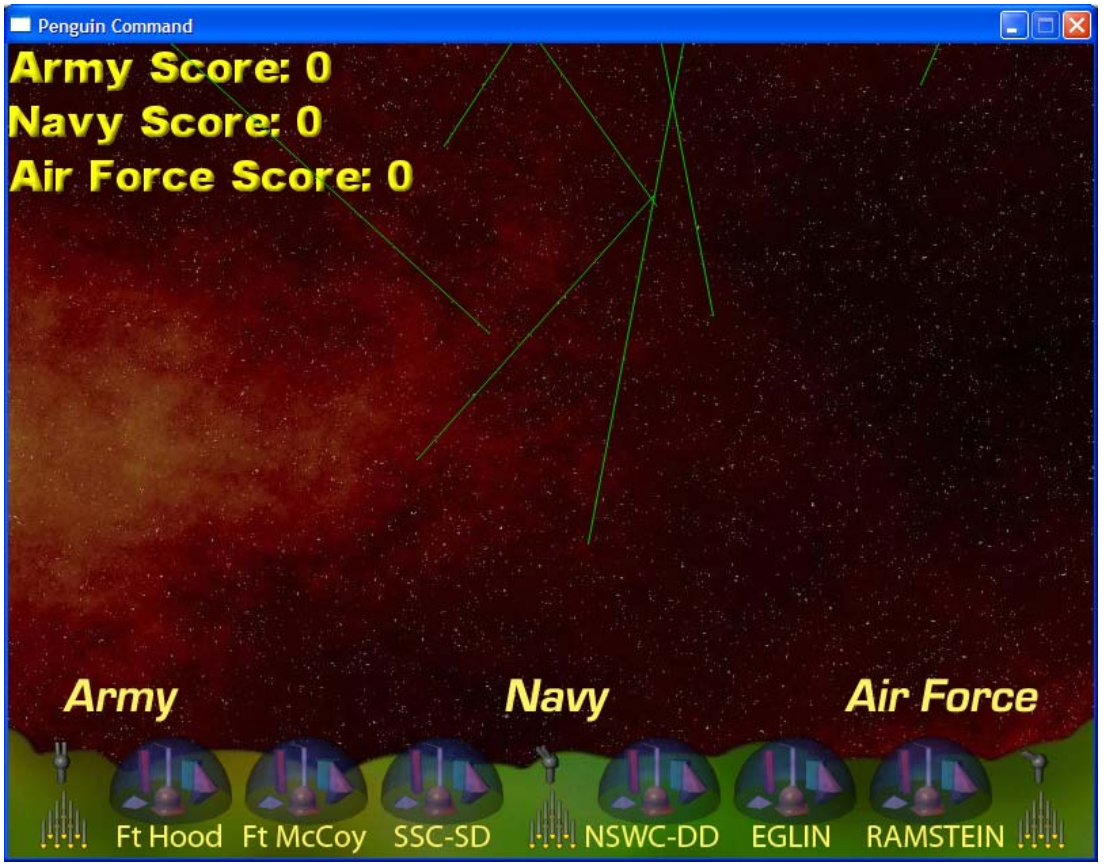
Isolates real-time data performance from interference from non-real-time systems



- Data access from the Web Services or Enterprise networks does not hinder the real-time performance Network
- Additional portals to other systems can be added dynamically

Concepts DEMO

- Distributed C2
  - RT Pub/Sub
  - Web-based logistics
- Cached to RDBMS
  - Dynamic and automatic
  - Sync'd with data-model
- PDA inputs
  - Shooter
  - Targeter
  - Select Team



Thank You!

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You can also find more information at our booth, and more in depth demos, and presentations.